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Rotor assembly, in which at least one inter-claw space  
is sealed by the fan

#### Area of the invention

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The invention concerns in general rotating electrical machines in particular automobile vehicle alternators.

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More specifically the invention according to a first aspect concerns a rotor assembly in particular for an automobile vehicle alternator, this assembly being mounted rotating about an axis of rotation and comprising two magnet wheels with claws separated by axial spaces and arranged opposite each other, each wheel comprising a end shield approximately perpendicular to the axis and the claws extending axially from the end shield towards the other wheel, the claws of one wheel being attached to the end shield by respective bases mutually separated by peripheral spaces, the assembly comprising at least one fan positioned on the axial face of the end shield of the one wheel opposite the other wheel.

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#### Prior art

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Assemblies of this type are known from the prior art, for example document EP A 0 515 259 (US A 5 270 605) and are widely used in internally ventilated compact alternators of automobile vehicles.

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#### Object of the invention

One constant objective of research in the field of alternators is to reduce the noise produced by rotation of the rotor assembly.

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To this end the rotor assembly of the invention, while complying with the generic definition given in the introduction above, is essentially characterised in that part of this fan axially seals at least partly one of the peripheral spaces.

In a possible embodiment of the invention, the fan comprises a plate approximately perpendicular to the axis and attached to the end shield, and blades projecting from the plate.

Advantageously a sealing section of the plate comes to seal axially at least one of the peripheral spaces.

Preferably said sealing part of the plate carries an axial relief extending from the plate between the claws.

In this case the axial relief can be shaped so as to serve as a fixing clip for the fan on the corresponding magnet wheel.

For example the plate comprises a solid part of approximately annular form.

According to an embodiment of the invention, a zone of the solid part constitutes the sealing part.

Also the claws have radially external faces defining the diameter of the rotor assembly, the solid part having an external diameter equal to or less than the diameter of the rotor assembly.

Alternatively the sealing part of the plate protrudes radially towards the outside from the solid part.

In this case the solid part can have a radially external edge in which is hollowed out at least one recessed zone, the sealing part extending from the base of the recessed zone.

Advantageously said sealing part is inclined axially from the solid part of the plate at the side of the claws.

In this case the fan can comprise a blade extending at least partly over the sealing part.

In a first embodiment the fan is moulded.

In the second embodiment the fan is made of folded metal sheet.

In this second embodiment also a so-called sealing part of the plate comes to seal axially at least one of the peripheral spaces.

According to an embodiment, the plate comprises a solid part of approximately annular form, a zone of this solid part constituting the sealing part.

- 5 According to another embodiment, the plate comprises a solid part of approximately annular form, said sealing part of the plate comprising a tab protruding radially towards the outside from the solid part.

In this case the tab can be inclined axially from the solid part at the side of the claws.

- 10 According to another embodiment the plate comprises support parts for the blades cut out of the periphery of the plate, one of the support parts constituting the sealing part.

Also the fan can comprise a second plate attached to the plate and supporting the blades, the one plate and the second plate being able to comprise at least one sealing part.

- 15 Alternatively the plate and the second plate each comprise at least one sealing part.

In this case the plate and the second plate can comprise respective complementary sealing parts sealing the same peripheral space.

- 20 Advantageously the plate is attached to the axial face of the end shield of the magnet wheel, the second plate being positioned on a side of the plate opposite said axial face.

Conversely the second plate can be attached to the axial face of the end shield of the magnet wheel, the plate being positioned on a side of the second plate opposite said axial face.

- 25 In all cases the peripheral space may be partly or totally sealed. Similarly all peripheral spaces or just some may be sealed.

In a second aspect, the invention concerns an alternator or alternator-starter of an automobile vehicle comprising a rotor assembly with the characteristics described above.

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### Brief description of the drawings

Other characteristics and advantages of the invention will become clear from the description below which is provided for information and is in no way limitative, with reference to the attached drawings in which:

- 10 - Figure 1 is a perspective view of a rotor assembly according to the prior art,
- Figure 2 is a perspective view of a fan of a rotor assembly according to a first embodiment of the invention in which the fan is moulded,
- Figure 3 is a perspective view along arrow III in figure 2,
- Figure 4 is a perspective view of the fan in figures 2 and 3 mounted on a
- 15 magnet wheel of the rotor assembly,
- Figure 5 is a perspective view along arrow V in figure 4,
- Figures 6 to 9 are views equivalent to figures 2 to 5 for a rotor assembly according to a variant of the first embodiment,
- Figure 10 is a perspective view of a fan of a rotor assembly according to a
- 20 second embodiment of the invention in which the fan is made of folded sheet metal,
- Figure 11 is a partial cross-section view in a radial plane of a magnet wheel on which is positioned a variant of the fan in figure 10,
- Figure 12 is an axial view of a rotor assembly according to a variant of the
- 25 second embodiment of the invention, and
- Figure 13 is a perspective view of the magnet wheel in figure 1.

### Description of embodiments of the invention

- 30 Figure 1 shows a rotor assembly 1 for an automobile vehicle alternator rotating about an axis of rotation X-X'. This assembly is shrunk onto a shaft 2 and firmly attached to this in rotation about axis X-X' by splines carried by this shaft 2, these splines co-operating with grooves arranged in the rotor assembly 1.

The rotor assembly 1 comprises two magnet wheels with claws 10 firmly attached to the shaft 2 and separated by an axial spacing, a hub (not shown) enclosed between the two magnet wheels 10 and an inductive coil 21 wound on the hub.

The magnet wheels 10 each have the general form of a disc centred on axis X-X' and are arranged facing each other. Each wheel 10, as is shown in figure 1, comprises an end shield 11 in the form of a disc centred on axis X-X' and approximately perpendicular to this axis, and claws 12 arranged in a circle on the outer periphery of the end shield 11 and spaced regularly along this periphery.

The end shield 11 is pierced by a central bore holding the shaft 2.

The claws 12 are made of the same material of the end shield 11 and extend axially from the end shield 11 towards the other magnet wheel 10. The two wheels 10 bear the same number of claws 12, the claws 12 of one wheel being angularly offset in relation to those of the other wheel such that the claws of the two wheels intermesh, a claw of one magnet wheel becoming axially engaged between two claws of the other magnet wheel.

The claws 12 (figure 13) of the same wheel 10 are attached to the end shield 11 by respective bases 121, these bases protruding radially from an outer edge of the end shield 11. The bases 121 are mutually separated by peripheral spaces 13 which, perpendicular to the axis of rotation X-X', have the general form of a ring sector.

Following the periphery of the end shield 11, alternately a space 13 is followed by a base 121.

The claws 12 also each comprise a head, also called a tooth, of globally trapezoid form 122, extending the base 121 axially towards the other wheel 10.

The heads 122 have radially outer faces 123 describing a cylinder coaxial to the axis of rotation X-X' and defining the diameter of the rotor assembly 1. These faces 123 viewed in planes perpendicular to the axis of rotation X-X' have respective widths which shrink from the base 121 towards the opposite magnet wheel 10. Here the heads 122 have a form similar to that described in document EP 0 515 259 to which reference is made for further details. The heads therefore have peripheral chamfers and anti-noise chamfers 126 described below.

The rotor assembly 1 comprises at least one fan 30 attached to an axial face 111 of the end shield 11 of one of the wheels 10, said face being turned in a direction opposite to the other wheel 10.

5 The base 121 (figure 13) is delimited from the side of the axial face 111 by a straight facet 124 extending in the same plane as said axial face, an oblique facet 125 linking the straight facet 124 to the outer face 123 of the head 122, and two chamfers 126 laterally framing the oblique facet 125 and thus linking the straight facet 124 to the outer face 123. The oblique facet 125 and the chamfers 126 are inclined axially towards the opposite magnet wheel 10 from the straight facet 124. The chamfers  
10 126 are slightly inclined laterally towards the adjacent claws 12.

According to the invention, part of this fan 30 seals at least partially one of the peripheral spaces 13 in an axial direction i.e. parallel to the axis of rotation X-X'.

Here the term seal means that said fan part comes to close the peripheral space 13 on an axial side opposite the other wheel 10. Said fan part thus extends between the  
15 two bases 121 framing the peripheral space 13, from the one to the other.

It is positioned against the straight facets 124 of these bases or at least extends to the immediate proximity of the straight facets such that the space between said fan part and the bases is very small in relation to the dimensions of the peripheral space 13. Also said fan part extends over the majority of the radial height of the peripheral  
20 space 13.

The fan 30 comprises a plate 31 approximately perpendicular to axis of rotation X-X' and attached to the end shield 11, and blades 32 protruding from the plate 31 in the direction opposite the wheel 10. The fixing to the end shield is achieved for example by riveting and/or gluing.

25 In a first embodiment corresponding to figures 2 to 9, the fan 30 is moulded. It is typically made of plastics material but can also be made of other materials.

As will be seen on figures 2 and 3, the so-called sealing parts 311 of the plate 31 come to seal axially the peripheral spaces 13.



Naturally it is possible that the sealing parts 311 of the plate 31 do not seal all the peripheral spaces 13 but only some of them.

As will be seen on figures 2 and 3, the plate 31 comprises a solid part 312 of approximately annular form, and an edge 313 of axial orientation standing on a radially inner edge of the solid part. The edge 313 of annular form delimits a central opening. Figure 4 shows that the solid part 312 has an outer diameter equal to or less than the diameter of the rotor assembly. The radially outer edge of the solid part 312, following a radial direction, reaches the level of the oblique facets 125.

The blades 32 project axially on a face of the plate 31 opposite the end shield 11. In the embodiments in figures 2 to 9, these blades have an elongated form following a longitudinally curved direction running generally from the inside towards the outside of the fan. These blades 32 have an outer longitudinal end stopping on the radially outer edge of the solid part 312.

The sealing parts 311 are formed by zones of this solid part 312, the zones being regularly spaced along the outer edge of the solid part and lying axially in the extension of the peripheral spaces 13.

Nothing separates the sealing parts 311 from the rest of the solid part 312.

In a particularly advantageous manner the sealing parts 311 each bear an axial relief 314 extending from the plate 31 between the claws 12.

On figure 3 it can be seen that these reliefs 314 each have the form of a thin tab firmly attached to a face of the plate 31 turned towards the end shield 11 and extending from a point on this face situated radially remote from the outer edge of the solid part 312.

The tab comprises a first face 315 extending obliquely from the solid part 312 axially and radially towards the outside, and a second face 316 extending the first parallel to the axis of rotation X-X'.

The first face 315 has a slight concave curvature turned towards the axis of rotation X-X' and seals the space between the chamfers 126 of the two claws 12 framing the peripheral space in which is engaged the tab.

The second face 316 lies in the extension of the outer faces 123 of the two claws and here partially seals the space separating these two outer faces over a short axial length.

Each relief 314 carries an axial reinforcing rib 317 extending from the plate 31 along and first and second faces 315 and 316. The faces extend axially in the direction opposite the blades 32.

Naturally it is possible to ensure that only certain sealing parts carry axial reliefs.

It is noted that the first face 315 of reliefs 314 expands from the plate 31 up to the second face. Viewed peripherally to axis X-X', the first face has a width which is relatively smaller close to the solid part 312 and relatively larger at the junction with the second face 316. Therefore the axial reliefs 314 can serve as fixing clips for the fan 30 on the corresponding magnet wheel 10.

In an embodiment shown on figures 6 to 9, the sealing parts 311 comprise axial reliefs 314 which then have the double function namely of sealing and as a fixing clip.

In these cases zones 318 of the solid part 312 situated axially in the extension of axial reliefs 314 are recessed. These zones would constitute the sealing parts 311 on figures 2 to 5. These recessed zones 318 are hollowed from the outer edge of the solid part 312 and each have a general U-shape. They are delimited by a base and two lateral sides diverging from the base up to the outer edge of the solid part 312.

The first face 315 of the axial reliefs 314 thus each extend from the base of a recessed zone 318 and are inclined from the base towards the outside and towards the claws 12.

Advantageously an extended blade 32 can be provided extending along the first face 315 of each axial relief 314. A longitudinal, radially inner extremity of this blade is situated on the solid part 312. The longitudinal opposite extremity of the extended blade is located at the junction between the first and second faces 315 and 316.

Thus a centrifugal type fan as shown on figures 2 and 3 can be transformed into a helical centrifugal fan. A centrifugal fan draws the air parallel to its axis of rotation



and expels the air perpendicular to this axis. A helical centrifugal fan draws in the air parallel to its axis of rotation and expels the air in a direction inclined in relation to this axis, the angle in incline being greater than zero and less than  $90^\circ$ .

It is noted that in this variant embodiment, the reinforcement rib of figure 3 replaced  
5 by three webs 319 forming a reinforcement box for the axial relief 314.

A central web 319 extends parallel to the axis of rotation X-X' from the base of the recessed zone 318. Two lateral webs 319 link the opposite lateral edges of the central web 319, turned towards the two claws framing the axial relief 314, to the lateral edges of the first and second faces, themselves turned towards the two claws.

10 The central web is relatively narrower than the first and second faces 315 and 316 such that the lateral webs diverge from the central web to the first and second faces. Viewed in cross-section perpendicular to the axis of rotation X-X', the reinforcement box therefore has trapezoidal sections, the central web of which constitutes the small base. The lateral webs allow matching of the form of the chamfers 126 of the claws  
15 and as a variant are extended for this purpose.

In a variant embodiment not shown, the plate 31 comprises a solid part 312 of approximately annular form, the sealing parts 311 protruding radially towards the outside in relation to the solid part 312.

In this case the solid part 312 has an outer diameter smaller than on figures 2 to 9  
20 corresponding approximately to the diameter of the end shield 11.

In a second embodiment corresponding to figures 10 to 12, the fan 30 is made of folded sheet metal. It can therefore be fixed by welding to the end shield 11. As a variant the fixing is achieved by riveting.

As before, plate 31 of this fan comprises a solid annular part 312 and blade support  
25 parts 320 cut out of the periphery of this plate.

These support parts 320 extend towards the outside from a peripheral outer edge of the solid part 312. They each have a generally triangular form, one of the sides of which constitutes a common edge with the solid part 312 and one of the summits of which points in the radially outer direction. The blade 32 extends along a side of the

triangle approximately between said summit pointing towards the outside and the outer edge of the solid part 312.

As in the first embodiment, a zone of this solid part 312 can constitute the sealing part 311.

- 5 In the example embodiment shown on figures 10 and 12, the sealing part 311 comprises a tab 321 protruding radially towards the outside from the solid part 312.

This tab 321 may, as shown in figure 10, extend in the same plane perpendicular to the axis of rotation X-X' as the solid part 312.

- 10 It can have multiple forms: rectangular, oval, oblong etc. It can seal the peripheral space 13 fully or partly.

- The tab 321 can also be inclined axially from the solid part 312 at the side of the claws 12 as shown on figure 11. In this case it can have two faces like the axial relief 314 of the first embodiment: an oblique face of one piece with the solid part 312 and coming to seal the space between the chamfers 126 of the two claws 12 between  
15 which is engaged the tab 321, and an axial face extending the oblique face and coming to seal the space between the outer faces 123 of the claws 12.

The tab also may comprise only the oblique face.

In a variant embodiment shown on figure 12, the sealing part 311 can comprise a support part 320 arranged axially in the extension of the peripheral space 13.

- 20 The fan 30 can comprise one, two or more than two sealing parts 311.

These sealing parts 311 may all be of the same type i.e. all comprising a zone of the solid part 312, or all comprising a tab 321 or all comprising a blade support part 320. But a single fan can also comprise several support parts 311 of different types without limitation of the possible combinations.

- 25 The fan 30 can comprise a second plate 34 (figure 12) perpendicular to the axis of rotation X-X', of the same type as the plate 31 and also bearing blades 32.

The second plate 34 is positioned on the axial face 111 of the end shield 11 of the magnet wheel 10, the plate 31 being attached on one side of the second plate 34 opposite said axial face 111. Each plate can be fixed to the end shield 11 for example by welding, the most distant plate having passages for welding the closest plate to the end shield 11 and vice versa.

The solid parts 312 of the two plates are advantageously of the same diameter. The blade support parts 320 of the second plate 34 are angularly offset in relation to the blade support parts of the plate 31 such that the blades 32 of the second plate 34 intermesh between the blades of the plate 31.

Alternatively the plate 31 can be positioned on the axial face 111 of end shield 11 of the magnet wheel 10, the second plate 32 being attached on one side of the plate 31 opposite said axial face 111.

At least one on the plate 31 and second plate 34 comprises one or more sealing parts 311. These parts can be of any type.

It is possible that the plate 31 and the second plate 34 each comprise one or more sealing parts 311.

In this case the same peripheral space 13 can be sealed with two complementary sealing parts, the one carried by the plate and the other by the second plate.

It will be clearly evident that the rotor assembly described above presents multiple advantages.

To seal one or more of the peripheral spaces 13 allows a reduction of the harmonics created by the magnet wheels and a reduction in the acoustic interaction between the rotor assembly and the stator cooperating with this assembly.

This is particularly important because the most recent fans are extremely quiet. They generate very little noise which no longer covers the harmonics created by the magnet wheels.

It is known that the peripheral spaces separating the claws of one magnet wheel are zones where during rotation great turbulence is created, with fluid detachment from

the solid surface and hence significant pressure differences, which leads to the creation of aerodynamic noise and hence harmonics. The sealing of these spaces achieves a significant reduction in this turbulence and in noise due to rotation of the machine.

- 5 This seal is achieved in a particularly convenient and economic manner as no part is added to the rotor assembly. Elements already existing in this assembly are used, cut or shaped differently to seal the peripheral spaces.

10 It is possible to achieve the seal in an asymmetrical fashion on the same magnet wheel i.e. to seal only certain peripheral spaces distributed irregularly or seal the peripheral spaces each in a different manner.

Advantageously the harmonic signals are thus distributed over a wider range.

Also it is evident from the description above that an in-depth seal can be obtained between the claws which increases the efficacy of the reduction of harmonics.

15 Finally it is possible to omit the chamfers 126 because of the presence of these sealing parts 311. These chamfers have the same function as the sealing parts, namely to reduce the noise produced by the magnet wheels in rotation. They are costly to machine and can affect the electromagnetic performance of the rotor by diminishing the passage of electromagnetic flux in the claw. In this case the oblique facet 124 is simply extended transversely on both sides.

20 Although we have described a rotor assembly fitted with a single fan, this assembly can be fitted with two fans without leaving the scope of the invention. The two fans are fixed to the two opposite magnet wheels and allow sealing of the peripheral spaces of the two wheels.

25 As will be evident, the axial reliefs 314 constitute a profiled tab so as to adapt to the inter-claw spaces.

The tabs 321, 314 allow at least partial sealing of the spaces between the claws in a more effective manner than the embodiment in figure 12. In fact the shape of the tabs 321 and 314 is not limited by the shape of the blades and the function of the blades, in particular when these are made of sheet metal.

It will be evident that the rotor according to the invention is advantageously intended to be mounted in an internal fan alternator as described for example in document EP-A 0515 259. Such an alternator comprises a stator surrounding a claw rotor.

5 The rotor is firmly attached to the shaft 2 mounted centrally in rotation via ball bearings, one of which is visible in figure 1, in a housing with two parts called a front bearing shell and rear bearing shell. The bearing shells are hollow and each has a base fitted with openings to form air inlets and a peripheral edge also fitted with openings to form air outlets. The base of the bearing shells are globally oriented transversely and centrally carry a ball bearing for rotational mounting of the rotor  
10 support shaft. The bases are each extended at their outer periphery by the peripheral edge of globally axial orientation and with a shoulder for mounting the body of the stator carrying the coil with a plurality of phase windings, the caps of which extend protruding axially on either side of the stator body below the openings of the peripheral edges of the bearing shells when assembled for example with  
15 screws or stud bolts, to form the housing for the stator and rotor. The rotor carries at least on one of its axial ends a fan mounted radially below the cap concerned. The rear bearing shell carries at least one brush carrier while a pulley attached to the rotor support shaft is adjacent to the front bearing shell. For the other constituents of the alternator, reference is made to the document cited above. A rectifier bridge for  
20 example with diodes is linked to the phase windings. As a variant this rectifier bridge is shaped to form an inverter as described for example in document FR-A-2 745 444 to inject current into the phase windings of the stator to cause the alternator to function as an electric motor in particular to start the combustion engine of the automobile vehicle, such an alternator being called an alternator-starter.

25 In all cases when the rotor support shaft turns, the fan or fans allow creation of an air current between the air inlet and outlet openings passing through the caps of the stator winding.

Naturally the present invention is not limited to the embodiments described.

30 Thus the annular edge 313 in the form of a crown in figure 9 can comprise a magnetic target which in association with at least one sensor ensures magnetic monitoring of the rotation of the rotor as described in document FR A 2 857 171, to

which reference is made for further details, the alternator in this case being an alternator-starter.

More precisely the target can comprise a plasto-magnet in the form of a crown which is moulded onto the end shield of the fan as in figures 2A and 2B of the said  
5 document.

The holes, not referenced, which are seen in figure 9 can then serve for removal from the mould.

Thanks to the target and the sensor, at the correct moment electric current can be injected into the phase winding concerned of the stator winding as described for  
10 example in documents FR-A-2 745 444, EP A 0 260 176 and WO 01/69762.

All combinations are possible.